Docket No.: 08204/0200314-US0
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Letters Patent of:
Keith R. Reynolds et al.

Patent No.: 7,197,661

Issued: March 27, 2007

For: SYSTEM AND METHOD FOR DYNAMIC MIRRORING OF A NETWORK CONNECTION

REQUEST FOR CERTIFICATE OF CORRECTION
PURSUANT TO 37 CFR 1.322

Attention: Certificate of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Upon reviewing the above-identified patent, Patentee noted typographical errors which should be corrected. A listing of the errors to be corrected is attached.

The typographical errors marked with a "P" on the attached list are not in the application as filed by applicant. Also given on the attached list are the documents from the file history of the subject patent where the correct data can be found.

The errors now sought to be corrected are inadvertent typographical errors the correction of which does not involve new matter or require reexamination.

Transmitted herewith is a proposed Certificate of Correction effecting such corrections. Patentee respectfully solicits the granting of the requested Certificate of Correction.

The Commissioner is authorized to charge any deficiency of up to $300.00 or credit any excess in this fee to Deposit Account No. 04-0100.

Dated: May 31, 2007

Respectfully submitted,

By_____

Flynn Barrison
Registration No.: 53,970
DARBY & DARBY P.C.
P.O. Box 770
Church Street Station
New York, New York 10008-0770
(212) 527-7700
(212) 527-7701 (Fax)
Attorneys/Agents For Applicant

PTO/SB/44 (04-05)
Approved for use through 04/30/2007. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,197,661

APPLICATION NO.: 10/729,720

ISSUE DATE : March 27, 2007

INVENTOR(S) : Reynolds et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the face page, in field (56), under "Other Publications", in column 1, line 2, delete "Dicitonary" and insert - - Dictionary - -, therefor.

In column 7, line 38, delete "10." and insert - - 110. - -, therefor.

In column 16, line 27, in Claim 30, delete "resource" and insert - - resource, - -, therefor.

MAILING ADDRESS OF SENDER (Please do not use customer number below):
John W. Branch, Esq.
DARBY & DARBY, P.C.
P.O. Box 770
Church Street Station
New York, NY 10008-0770

Darby & Darby

Issued Patent Proofing Form
Note: P = **PTO Error**
A = **Applicant Error**
File#: **08204/0200314-US0**

US Serial No.: **10/729,720** US Patent No.: **US 7,197,661 B1** Issue Dt.: **Mar. 27, 2007**
Title: **SYSTEM AND METHOD FOR DYNAMIC MIRRORING OF A NETWORK CONNECTION**

Sr. No.	P/A	Original		Issued Patent		Description Of Error
		Page	Line	Column	Line	
1	P	Page 1 of 1 List of references cited by examiner (06/16/2006)	Entry 1 Line 1 (Non–Patent Documents)	First Page Col. 1 (Other Publications)	2	Delete "Dicitonary" and insert - - Dictionary - -, therefor.
2	P	Page 11 Specification (12/05/2003)	21	7	38	Delete "10." and insert - - 110. - -, therefor.
3	P	Page 8 Claims (09/14/2006)	2	16	27 (Approx.)	In Claim 30, delete "resource" and insert - - resource, - -, therefor.

US007197661B1

(12) **United States Patent**
Reynolds et al.

(10) **Patent No.: US 7,197,661 B1**
(45) **Date of Patent: Mar. 27, 2007**

(54) **SYSTEM AND METHOD FOR DYNAMIC MIRRORING OF A NETWORK CONNECTION**

(75) Inventors: **Keith Robert Reynolds**, Issaquah, WA (US); **John R. Hughes**, Seattle, WA (US)

(73) Assignee: **F5 Networks, Inc.**, Seattle, WA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 496 days.

(21) Appl. No.: **10/729,720**

(22) Filed: **Dec. 5, 2003**

(51) **Int. Cl.**
G06F 11/00 (2006.01)

(52) **U.S. Cl.** **714/4**

(58) **Field of Classification Search** 714/4
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,187,706	A *	2/1993	Frankel et al.	370/217
2002/0176355	A1	11/2002	Mimms	
2004/0003094	A1 *	1/2004	See	709/227

OTHER PUBLICATIONS

"Compress" "Decompress" "SSL" "Proxy" Microsoft Computer Dictionary (fifth edition). Copyright 2002. Microsoft Press.*

Null, Linda: "The Essentials of Computer Organization and Architecture." Copyright 2003. Jones and Bartlett Computer Science. pp. 521-524, 538-546.*

BIG-IP Reference Guide, Version 4.5, Chapter 13 Configuring a Redundant System, pp. 13-1-13-20.

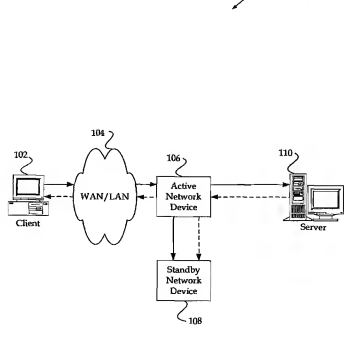
* cited by examiner

Primary Examiner—Robert W Beausoliel, Jr.
Assistant Examiner—Matt Urick
(74) *Attorney, Agent, or Firm*—Darby & Darby PC; Jamie L. Wiegand

(57) **ABSTRACT**

Methods and systems are directed to dynamically mirroring a connection between network devices. Mirroring is managed by forwarding a packet between a first network device and a second network device. In one method, the first network device receives the packet from a client and communicates the packet to the second network device. A forwarding device, pre-determined from the first and second network devices, forwards the packet to a server. The first network device receives a response from the server, and communicates it to the second network device. The forwarding device forwards the response packet to the client. In one configuration, the first network device and forwarding device is an active device, and the second network device is a standby device. In another configuration, the first network device is a standby device, and the second network device and forwarding device is an active device.

45 Claims, 8 Drawing Sheets



Standby network device **108** is configured to perform substantially the same operations on the mirrored packet as active network device **106** might perform. However, standby network device **108** is configured typically not to send out its output, unless it becomes the active network device. During a complex operation, such as SSL, standby network device **108** is configured to receive and employ certain information from active network device **106**. Such information may include a random seed, a server-random, encryption keys, certificates, and the like. Standby network device **108** may also receive and employ certain information from active network device **106** during other situations. This additional information may include an initial sequence number, and the like.

Communicating virtually the same packets to standby network device **108** enables standby network device **108** to construct virtually an equivalent internal state, substantially similar to one maintained by active network device **106**. This enables a more rapid failover response should active network device **106** fail than might occur should standby network device **108** have to regenerate the actions from static information about the connections. This also enables complex, high-level protocols, such as compression, SSL, and the like, to be mirrored with minimal additional state information transferred from active network device **106**. In some instances, such as with a compression action, virtually no transfer of state information may be needed.

FIG. **2** illustrates one embodiment of an environment in which a system operates for managing reliability of a mirrored connection using a standby response configuration. Not all the components may be required to practice the invention, and variations in the arrangement and type of the components may be made without departing from the spirit or scope of the invention.

As shown in the figure, system **200** includes client **102**, wide area network (WAN)/local area network (LAN) **104**, active network device **206**, standby network device **208**, and server computer **110**. Components numbered similar to those in FIG. **1** operate substantially similar. Active network device **206** is configured to perform similar to active network device **106** in FIG. **1**. Similarly, standby network device **208** is configured to perform similar to standby network device **108** in FIG. **1**. A difference between the environment shown in FIG. **1** and that shown in FIG. **2** is that the WAN/LAN **104** is in communication with client **102**, active network device **206**, and standby network device **208**. Active network device **206** is also in communication with standby network device **208** and with server computer **110**. Standby network device **208** is further in communication with server **110**.

The flow of packets shown in FIG. **2** is described in more detail below in conjunction with FIG. **6**. Briefly, however, as shown in FIG. **2**, standby network device **208** is configured to send substantially all mirrored packets, including acknowledgement packets as appropriate, forwarded connection data, and the like, that might typically be sent by active network device **106** as shown in FIG. **1**. Moreover, should a packet be dropped, corrupted, and the like, while being transferred between active network device **206** and standby network device **208**, the appropriate network peer is configured to retransmit the packet, data, and the like, virtually the same as if it had been dropped at any other point in the network.

FIG. **3** illustrates one embodiment of an environment in which a system operates for managing reliability of a mirrored connection using a standby first configuration. Not all the components may be required to practice the invention, and variations in the arrangement and type of the components may be made without departing from the spirit or scope of the invention.

As shown in the figure, system **300** includes client **102**, wide area network (WAN)/local area network (LAN) **104**, active network device **306**, standby network device **308**, and server computer **110**. Components numbered similar to those in FIG. **1** can operate in substantially similar ways. Active network device **306** is configured to perform similar to active network device **106** in FIG. **1**. Similarly, standby network device **308** is configured to perform similar to standby network device **108** in FIG. **1**. A difference between the environment shown in FIG. **1** and that shown in FIG. **3** is that the WAN/LAN **104** is in communication with client **102**, active network device **306**, and standby network device **308**. Active network device **306** is also in communication with standby network device **308** and with server computer **110**. Standby network device **308** is further in communication with server **110**.

The flow of packets shown in FIG. **3** is described in more detail below in conjunction with FIG. **7**. Briefly, however, as shown in FIG. **3**, reliability of mirrored connections is ensured by arranging packets to be sent to standby network device **308** first. Standby network device **308** is configured to forward the packets to active network device **306**. Active network device **306** forwards the packets as with non-mirrored connections.

FIG. **4** illustrates a functional block diagram of one embodiment of a network device in which the invention may be practiced. It will be appreciated that not all components of network device **400** are illustrated, and that network device **400** may include more or fewer components than those shown in FIG. **4**. Network device **400** may operate, for example, as a router, bridge, firewall, gateway, traffic management device, distributor, load balancer, server array controller, or proxy server. The communications may take place over a network, such as network **104** in FIGS. **1–3**, the Internet, a WAN, LAN, or some other communications network known to those skilled in the art.

As illustrated in FIG. **4**, network device **400** includes a central processing unit (CPU) **402**, mass memory, and a network interface unit **412** connected via a bus **404**. Network interface unit **412** includes the necessary circuitry for connecting network device **400** to network **104**, and the like, and is constructed for use with various communication protocols including the TCP/IP and UDP/IP protocol. Network interface unit **412** may include or interface with circuitry and components for transmitting messages and data over a wired and/or wireless communications medium. Network interface unit **412** is sometimes referred to as a transceiver.

The mass memory generally includes random access memory ("RAM") **406**, read-only memory ("ROM") **414**, and one or more permanent mass storage devices, such as hard disk drive **408**. The mass memory stores operating system **416** for controlling the operation of network device **400**. The operating system **416** may comprise an operating system such as UNIX, LINUX™, Windows™, and the like.

In one embodiment, the mass memory stores program code and data for implementing a connection mirroring **418**, and related program code and data, in accordance with the present invention. The mass memory may also store additional programs **424** and data for performing the functions of network device **400**. Programs **424** may also include applications that are employed by connection mirroring **418** to handle complex, high-level protocols, including, but not limited to, compression and Secure Socket Layer (SSL) operations on packets.

forwarding the copy of the packet to another network device, wherein the copy of the packet is forwarded exclusively by the standby network device;

receiving, exclusively by the active network device, a response packet from the other network device;

communicating a copy of the response packet to the standby network device; and

forwarding, exclusively by the standby network device, the copy of the response packet towards the resource.

20. The method of claim **19**, further comprising:

synchronizing the standby network device with the active network device by communicating pre-determined information about each active connection to the standby network device on a busiest connection first order of connections.

21. The method of claim **20**, wherein the pre-determined information includes at least one of a change in a sequence number, and a Network Address Translation (NAT), and a port address translation.

22. A method for mirroring a connection in a network, comprising:

receiving, exclusively by a standby network device, a packet from a resource;

forwarding a copy of the packet to an active network device;

forwarding a copy of the packet to another network device, wherein the copy of the packet is forwarded by the active network device;

receiving, by the standby network device, a response packet from the other network device;

forwarding a copy of the packet to the active network device; and

forwarding, exclusively by the active network device, the copy of the response packet towards the resource.

23. The method of claim **22**, wherein forwarding the copy of the packet to the other network device further comprises transforming the copy of the packet, and wherein forwarding the copy of the response packet further comprises transforming the copy of the response packet.

24. The method of claim **23**, wherein transforming the packet further comprises sharing information associated with the transformation between the active network device and the standby network device.

25. A network device, for mirroring a connection with another network device in a network, comprising:

a transceiver arranged to receive and forward a packet;

a processor, coupled to the transceiver, that is configured to perform actions, including:

receiving a packet from a resource, wherein the packet is sent exclusively towards the network device by the resource;

communicating the packet to the other network device;

if the network device is a forwarding device, exclusively forwarding the packet towards a server;

receiving a response packet from the server;

communicating the response packet to the other network device; and

if the network device is the forwarding device, exclusively forwarding the response packet towards the resource.

26. The network device of claim **25**, further comprising:

if the other network device is the forwarding device, enabling the other network device to forward the packet towards the server, and to forward the response packet towards the resource.

27. The network device of claim **25**, wherein the network device and the other network device are configured to operate as at least one of a load-balancer, a router, a firewall, a proxy, a bridge and a network address translation device.

28. A standby network device, for mirroring a connection with an active network device in a network, comprising:

a transceiver arranged to receive and forward a packet;

a processor, coupled to the transceiver, that is configured to perform actions, including:

receiving a packet exclusively from a resource;

communicating a copy of the packet to the active network device;

receiving a response packet from another resource, wherein the response packet is in response to the other resource receiving a copy of the packet exclusively from the active server; and

communicating a copy of the response packet to the active network device.

29. The standby network device of claim **28**, wherein the active device is configured to communicate an acknowledgement packet to the resource in response to receiving the copy of the packet, and to further communicate another acknowledgement packet to the other resource in response to receiving the copy of the response packet.

30. A system for mirroring a connection in a network, comprising:

(a) a first network device, configured to perform actions, including:

receiving a packet from a resource wherein the packet is sent exclusively towards the first network device by the resource;

sending the packet to a second network device;

if the first network device is a pre-determined forwarding network device, forwarding the packet towards another resource, wherein the packet is sent towards the other resource exclusively by the first network device;

receiving a response packet from the other resource; and

if the first network device is the pre-determined forwarding network device, forwarding the response packet towards the resource, wherein the response packet is sent towards the resource exclusively by the first network device; and

(b) the second network device, coupled to the first network device, and configured to perform actions, including:

receiving the packet from the first network device; and

if the second network device is the pre-determined forwarding network device, forwarding the packet towards the other resource, and forwarding the response packet towards the resource, wherein the packet is sent towards the other resource exclusively by the second network device, and the response is sent towards the resource exclusively by the second network device.

31. The system of claim **30**, wherein the first network device is an active network device, the second network device is a standby network device, and the forwarding network device is the active network device.

32. The system of claim **30**, wherein the first network device is an active network device, the second network device is a standby network device, and the forwarding device is the standby network device.

33. The system of claim **30**, wherein the first network device is a standby network device, the second network device is an active network device, and the forwarding device is the active network device.